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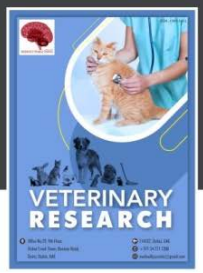

Prevalence of Gastrointestinal Nematode and Field Efficacy of Commonly Used Anthelmintics of Goats in Humbo Woreda of Wolaita Zone, Ethiopia

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Key words: Anthelmintic efficacy, gastrointestinal nematode, goats, Humbo Woreda, prevalence

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Abstract: The study was conducted to determine the prevalence of gastrointestinal nematodes of goats in Humbo Woreda of Wolaita zone from November, 2019 to March, 2020 and to investigate field efficacy of commonly used of anthelmintics against gastrointestinal nematode of naturally infected goats. A total of 384 goats were sampled for the presence of gastrointestinal nematodes and examined under microscope for the presence of nematode eggs and the number of eggs counted (quantified) using modified McMaster egg counting techniques. Out of 384 study animals, only 361 (94.0%) goats were found positive for nematode eggs of which 40 highly infected goats were used for the field efficacy trial and divided into four groups having 10 goats in each group. The first group was treated with albendazole, second with tetramisole, the third with ivermectin and the fourth were left untreated (as control). Faecal egg count reduction test was applied to determine the efficacy of anthelmintic at day 14 (post-treatment). Among anticipated risk factors, only the age, body condition and origin of goats showed statistically significant associations ($p<0.05$). The mean egg per gram of faeces at day 0 was >1300 for all treatment and control group while day 14 result nematodes for three treatment groups was 0. All the three anthelmintics tested revealed significant ($p<0.05$) reduction in nematode egg of goats at day 14. Faecal egg count reduction was 100% and same for all three treatment drugs. This study demonstrated that the prevalence of gastrointestinal nematode in goats was high thus, tested drugshad 100% efficacies against nematode of goats. In this regard, tested drugs can be used in the treatment of gastrointestinal nematode infections in goats.

INTRODUCTION

Gastrointestinal parasites infections are major health and production problems and cause high morbidity, mortality andgrowth retardations in small ruminants[1, 2] and impacted the health and wellbeing of goats[3-5]. Thus, they impose huge economic loss in many countries[6]. In Ethiopia, gastrointestinal parasitic infection is high in

goats due to suitable ecological factors for parasites such as humidity, temperature, rainfall, vegetation and management practices.

Anthelmintics treatment is the most common way of controlling gastrointestinal nematode infections of goats[7, 8]. Albendazole from benzimidazoles group, levamisole from imidazothiazoles group and ivermectin from macrocyclic lactones groups are most commonly used anthelmintics to control gastrointestinal nematode infection of goats in Ethiopia for many years[9]. But, their efficacy can be influenced by several factors. Under dosing, poly pharmacy and empirical medication, frequent and indiscriminate use of drugs are the important factors that reduce the efficacy of anthelmintics[10]. In addition, anthelmintics are also sold in the market like other commodity and farmers can access to this drug and use without manufacturer instruction and kept like any other materials in their home[11]. This in turn leads to the development of anthelmintics resistant in nematode parasites[12]. Currently, the problem of anthelmintic resistance is by far the most severe problem in goats and *Haemonchus contortus*, *Teladorsagia circumcincta*, *Trichostrongylus* spp. and *Cooperia* spp. develop multiple drug resistances[13]. Despite, indiscriminate uses of anthelmintic both by professional veterinarian and animal owners in Humbo Woreda of Wolaita zone, neither the status of GIN infection nor the efficacy of commonly used anthelmintic in goats was not done and published elsewhere. Therefore, the objectives of this study were to determine the prevalence of GINs and investigate field efficacy of commonly used anthelmintics against GINs of goats in Humbo Woreda of Wolaita zone.

MATERIALS AND METHODS

Study area: The study was conducted in Humbo Woreda, Wolaita zone, SNNPRs of Ethiopia. Humbo is located 350 km South of Addis Ababa (capital city of Ethiopia). It is located 1100-2300 m above sea level at 6°40'N latitude and 37°50'E longitude. The study area has mean annual temperature of 22°C and receives average rainfall of 1123.15 mm. It is bordered on the South by West Abaya, North by Sodozuria, East by Damote Woyde and West by Ofa Woredas. The number of sheep and goat in the woreda is estimated to be estimated 24.562 and 80.822, respectively[14].

Study animals: Goats having different age, sex and body conditions and kept under extensive production system in different kebele were considered as study animals. All goats were indigenous breed and the age of the animal was classified as young (age ≤1 year) and adult (age >1 year)[15]. Then, the age of goats was estimated based own owners information and using eruption pattern of teeth. Moreover, body conditions of the goats were determined by palpating and observing the vertebrae of loin regions. Thus, the body conditions were classified as poor, medium and good[16].

Study design: A cross sectional study was conducted to determine the prevalence GINs of goats in Humbo Woreda of Wolaita zone from November, 2019 to March, 2020.

Sampling methods and sample size determination: Sample size was calculated using 95% level of confidence, 50% expected prevalence since there was no previous work conducted in this study area and 0.05% desired absolute precision as described by Thrusfield[17]. The formula is as follow:

$$n = \frac{Z^2 Pexp\ (1\text{-}Pexp)}{d^2}$$

Where:

n = Require sampling size
Pexp = Expected prevalence
d^2 = Desired absolute precision
Z = Constant value from normal distribution table at a given confidence level (1.96)

Therefore, a total of 384 goats were selected and included in this study. Seven Kebele namely, Shocara Ogadema, Abala Sipa, Humbo 01, Larena Amba, Humbo 02, Ella and Gutato Larena were involved in the study. Thus, the owner of the goats and number animals (goats) were recorded. Owners of animal having one goat, the goats were sampled but for those owners having more number of goats, simple random sampling method was applied to select goats participating in the study.

Faecal sample collection and laboratory techniques employed: About 10 g of fecal samples was collected with examination glove directly from the rectum of each study animal. The collected fecal samples were placed in a clean dry universal bottle. Each specimen was labeled with the cod number given to the animal, date of collection, owner's name and place of collection with permanent marker. The samples were transported to the parasitology laboratory of School of Veterinary Medicine, Wolaita Sodo University in side ice box. Faecal samples were examined either on the day of collection or stored in a refrigerator for processing in the next day.

Flotation fluid was prepared with the help of NaCl and added to the faecal sample. Then, measured amount of faeces was mixed with a known volume of floatation solution. The ratio of faeces to flotation solution was 1:30.

Then, the filtrate was homogenized by stirring before a small amount was taken to fill the chambers of the McMaster slide with a Pasteur pipette. The slide was left for a period of time to allow eggs to float up before being examined microscopically to count the eggs present. The eggs of nematode were counted using McMaster egg counting chamber in accordance with those described by Coles *et al*.[18].

Experimental animal grouping: From a total of 361 goats which were found positive for GINs, only 40 goats having FEC >1300 were randomly allocated into control and treatment groups (10 goats each group). On day 0 faecal samples were collected to determine pre-treatment FEC and each group were treated with an anthelmintic according to the recommended dose and the control group was left untreated. Thus, two groups (10 goats in each) were orally treated with albendazole and tetramisole, respectively. The third group (10 goats) was treated by ivermectin in subcutaneous routs of administration. The 10 goats were left untreated/control as a fourth group. Calculated dose of each anthelmintics was given for each experimental goats at the same day.

The anthelmintics tested and dosages used for each treatment group of goats were tetramisole (H-Tetra600, Hebei Hope Harmony Pharmaceutical Co., Ltd., China, 22.5 mg kg^{-1}), albendazole (ASHIALBEN®300, Ashish Life Science, Indian, 7.5 mg kg^{-1}) and ivermectin (KMECTIN1%, Ashish Life Science, Indian, 0.2 mg kg^{-1}).

Fecal Egg Count Reduction (FECR) test: On the 14th days after the treatment, all experimental goats (treated and control)were sampled again. The GINs fecal egg counts were made using modified McMaster technique with a sensitivity of 15 eggs per gram and FECR test was made as described by Coles *et al*.[18]. Then, the Fecal Egg Count Reduction (FECR%) was calculated using the formula:

$$FECR\% = 100(1-\underline{(Xt/Xc)})$$

Where:

Xt = Te arithmetic mean EPG in the anthelmintic treatment (t)

Xc = Arithmetic mean EPG in the untreated/control (c) group

Reduction in efficacy anthelmintics were considered to exist if the FECRT% of an anthelmintic treatment is <95%, the GINs were considered as resistance to a given antihelmetics as described by Coles *et al*.[18].

Data management and statistical analysis: The data obtained in this study were recorded in Microsoft-Excel spread sheet 2007 and coded. Then, the coded data was imported into Statistical Package for Social Sciences (SPSS ver. 20 Chicago, IL, USA). The prevalence was calculated as percent of infected goats from the total number of goats examined. The association between putative risk factors with the prevalence of GINs parasites were determined using Chi-square test (χ^2). The mean EPG and respective confidence interval for each risk factor (sex, body condition, age and origin) of goats were determined using descriptive statistics. Independent t-test also used to compare EPG result of treatment and control group at day 14 and $p<0.05$ were considered as statistically significant.

RESULTS AND DISCUSSION

Out of total 384 goats examined, 361 were infected by GINs. Thus, the overall prevalence of GINs infection in goats was 94.0%. Higher prevalence of GINs was recorded in male (96.1%, n = 73/76) as compared to female goats (93.5%, n = 288/308) but the variation was not statistically significant ($p>0.05$). On the other hand, the difference in the prevalence of GINs infection was statistically significant ($p<0.05$) between different age, body condition and origin groups of goats as shown in Table 1.

The overall mean EPG GINs was recorded as 945.5. The mean EPG of GINs in goats also depicted below in each risk factor thus, higher EPG was recorded in male ($x^- = 538.3$) as compared to female ($x^- = 966$) goats. Higher EPG of GINs were recorded in poor body condition goats and followed by medium and good body with respective mean EPG of 1148.9, 738.3 and 298.9. Similarly, higher EPG of GINs was recorded in adult ($x^- = 676.6$) than young ($x^- = 544.7$) goats. Moreover, higher EPG of GINs were counted in Abala Sipa ($x^- = 822.3$) and Ella ($x^- = 806.4$) while lower mean EPG of 366 and 540.4 were recorded in Humbo 01 and Larena Amba areas (Table 2).

The percentage reduction in fecal egg counts (FECR%) in the efficacy evaluation of albendazole, tretramizole and ivermectin revealed that all the three drugs were effective in the treatment of GINs of goats from clinical cure point of view. The mean EPG of day 14 sample were zero for all three treatment groups (albendazole, tretramizole and ivermectin), thus, treatment had significantly reduced the Egg Per Gram of feces (EPG) to zero when compared to that in the untreated control group ($p<0.05$). In the goats of Humbo Woreda, GINs were susceptible to albendazole, tretramizole and ivermectin anthelmintics as shown in Table 3.

The mean EPG of GINs in albendazole, tetramisole and ivermectin treatment groups were 1955, 1440 and

Table 1: Prevalence of gastrointestinal nematodes of goats in different risk factors

Risk factors/Categories	No. of examined animals	No. of positive animals	Prevalence (%)	χ^2	p-values
Sex					
Male	76	73	96.1	0.7	0.29
Female	308	288	93.5		
BCs					
Poor	53	53	100	9.99	0.007*
Medium	204	195	95.6		
Good	127	113	89		
Age					
Young	79	67	84.8	14.95	0.000*
Adult	305	294	96.4		
Origin					
S/Ogade	55	55	100.0	36.98	0.000*
Abala Sipa	54	54	100.0		
Humbo 01	47	47	100.0		
L/Amba	64	63	98.4		
Humbo 02	50	46	92.0		
Ella	50	42	84.0		
G/Larena	64	54	84.4		
Total		384	361	94.0	

* = Statistically significant; S/Ogade = Shocara Ogade; G/Larena = Gutato Larena; L/Amba = Larena Amba

Table 2: Mean EPG and its ranges of counts with respect to different risk factors

Risk factors/Categories	Mean EPG	Ranges	95% Cl
Sex			
Male	538.3	(100-4500)	323.5-778.7
Female	966	(100-3100)	642.7-1336.1
BCs			
Poor	1148.9	(100-4500)	859.6-1472.3
Medium	738.3	(100-3800)	526.6-981.8
Good	298.9	(100-4500)	123.5-507.5
Age			
Young	544.7	(100-3100	325.5-778.7
Adult	676.6	(100-4500)	451.1-929.8
Origin			
S/Ogade	676.6	(100-3800)	451.1-929.8
Abala Sipa	822.3	(100-4500)	516.0-1143.5
Humbo 01	366	(200-3100)	206.4-563.8
L/Amba	540.4	(100-2500)	372.4-738.2
Humbo 02	736.2	(100-3800)	483.0-985.0
Ella	806.4	(100-2400)	608.6-1016.9
G/Larena	704.3	(100-2400)	525.6-902.0
Over all	945.5	(100-4500)	851.1-145.5

EPG = Egg Per Gram of faeces; CL = Confidence Interval; S/Ogade = Shocara Ogade; G/Larena = Gutato Larena; L/Amba = Larena Amba

Table 3: Pretreatment and post treatment fecal egg count and faecal egg count reduction percentage in goats

Treatment group	No. goat	Mean EPG at D0±SE	95% CI	Mean EPG at D14±SD	95% CI	FECR (%)	Int.
Albendazole	10	1955±441	1136-2829	0 ± 0^a	0	100	Sus.
Tetramisole	10	1440±383	830-2180	0 ± 0^b	0	100	Sus.
Ivermectin	10	1435±343	765-2120	0 ± 0^c	0	100	Sus.
Control	10	1305±254	890-1839.	1410±266	940-1960	NA	

SE = Standard Error, NA = Not Applicable, CI = Confidence Interval, D0 = Day 0 and D014 = Day 14, FECR% = Faecalegg Count Reduction Percentage, EPG = Egg Per Gram of faeces, Int. = Interpretation; Sus. = Susceptible; ^{a,b,c}Statistically different at $p<0.05$

1435, respectively and mean EPG of GINs in the control/ none treated group was 1305 at day 0. Whereas, day 14 means EPG was zero for all the treatment groups but slight increase of 1410 EPG of GINs in the control/ untreated groups (Fig. 1 and Table 3).

The current study revealed that an overall prevalence of GIN parasites in goat was 94.0% in Humbo Woreda of Wolaita zone. This finding was extremely higher than previous reports of 43.9% by Balch[19] in Humbo town and surrounding, Wolaita zone, 49.2% by Muluneh *et al*.[20] in Dembia District, Northwest Ethiopia; 86.7% by Shankute *et al*.[21] in Debre Ziet, Central Ethiopia; 82.6% by Emiru *et al*.[22] in Gechi District, Southwest Ethiopia; 57.7% by Elemo and Geresu[23] in Bale zone, South Eastern Ethiopia; 52.6% by Kenea *et al*.[24] in Kaffa and Bench Maji Zones, Southwest Ethiopia; 50.8% by Admasu and Nurlign[25] in Kuarit District, North West Ethiopia. The variation in the prevalence of GINs in different study sites might be associated with difference in climatic and environmental

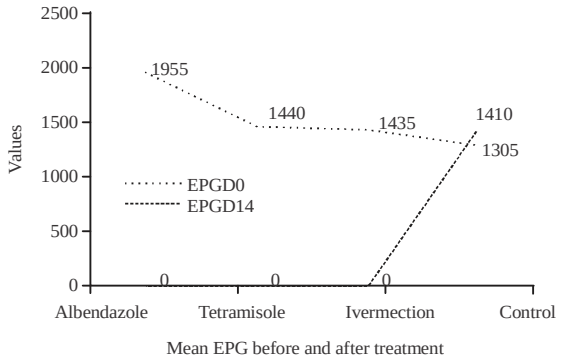

Fig. 1: The mean Egg Per Gram of faeces (EPG) before and after treatment in each experimental group; EPG = Egg Per Gram of faeces, EPG D0 = EPG at day 0 and EPG D14 = EPG at day 14

factors, extensive use of anthelmintic and seasonal difference of the study period as described by Rossanigo and Grunder[26]. In addition, highest prevalence in this study sites could be associated with sensitivity of McMaster egg chamber to detect the eggs[18].

Higher prevalence of GINs was recorded in male (96.1%) as compared to female goats (93.5%) but the variation was not statistically significant ($p>0.05$). Similar none statistically variation among sex groups were recorded by study of Muluneh *et al*.[20] in Northwest Ethiopia and Regassa in Western Oromia of Ethiopia. This could be due to deference in hormonal composition of female and male animals could also contribute for the difference in the prevalence[27]. On the other hand, the difference in the prevalence of GINs infection was statistically significant between different body condition groups of goats. Similar, significant association was reported by Kenea *et al*.[24] in Kaffa and Bench Maji Zones, Southwest Ethiopia and Elemo and Geresu[23] in Bale zone, South Eastern Ethiopia. This could be the result of longer exposition of adult goats to the parasite eggs and larvae during several grazing/browsing times. Moreover, poor body condition goats harbored higher percentage of GIN than medium and good body condition goats; similar study were reported by Elemo and Geresu[23] in Bale zone, South Eastern Ethiopia. Poor body condition might be due to malnutrition, other concurrent disease or the current parasitic infection which lead to poor immunological response to infective stage of the parasites. The prevalence of gastrointestinal parasites was significantly associated with origin of animals ($p<0.05$). Significant association of origin with gastrointestinal parasites was reported by Elemo and Geresu[23]. The difference in prevalence could be due to differences in husbandry practices within the extensive management systems and agro ecological factors study areas.

In this study, the mean fecal egg count values was 945.5 EPG amongst untreated goats which was lower than 2350 mean EPG among untreated goats as reported by Nalule *et al*.[28] in Kampala, Uganda and 1500 EPG in East African goats in Kenya[29]. But >350-481 mean EPG reports of GINs in goats of Gomba District, Uganda as described by Nsereko *et al*.[30]. This could be due to goats in Gomba District, Uganda grazed on natural pastures and they are not using both (graze and browse) since browsing reduces GIN infection in goats[31]. On the other hand, the probable explanation for relatively lower mean EPG of GINs as compared with the reports of Nalule *et al*.[28] and Waruiru[29] might be due to goats in our study area were both grazer and browse but in those areas were grazed strictly on grass pastures. This couldbe due to the abundance of secondary metablotes like tannins in higher plants and these metabolites may reduce GIN infection in goats when the animals were browsers as described by Kabasa *et al*.[31].

Egg counts amongst treated and control groups of goats ranged from mean EPG 1305-1955 at day 0 and all treatment group showed zero GIN eggs at day 14. Regassa *et al*.[32] also reported 0 GINs at day 14 in albendazole and ivermectin drugs but not for tetramisole. This significant reduction (tetramisole) and 0 results (albendazole and ivermectin) at day 14 indicated that the three selected drugs are highly efficacious against GINs treatment in goats of study area (Humbo Woreda)[30].

The anthelmintic efficacy of commonly used drug (albendazole, tetramisole and ivermectin) in GINs of goats were evaluated using FECRT techniques and interpretation was done according to the recommendation of World Association for the Advancement of Veterinary Parasitology as described by Coles *et al*.[18]. Thus, FECRT value <95% indicate that the nematode parasites are resistance for a given antihlmentics, however, in this study all the three (albendazole, tetramisole and ivermectin) drugs FECRT result were 100% which implies anthelmintic used in the study reduced FEC to 0 at day 14. Similar 100% FECR of GINs in goats was reported for albendazole and ivermectin but 96.6% FECR in tetramisole treated group of goats as described by Regassa *et al*.[32] in central Oromia of Ethiopia. Thus, albendazole, tetramisole and ivermectin drugs were highly efficacies against GINs of goats since FECR result was >95%[18, 32, 33]. The presence of no resistance might be associated to low frequency of anthelmintic treatment for goats in the study area[33]. Moreover, the absence of GINs resistance in goats to commonly used anthelmintic could also be explained by the low sensitivity of the FECRT to detect levels of resistance below 25% as described by Taylor *et al*.[34].

CONCLUSION

This study revealed that goats in study area (Humbo Woreda) were highly infected by GINs. Among anticipated risk factor like sex, body conditions, age and origin of goat's only body conditions, age and origin of animals showed statistically significant associations with the presence of GINs. Moreover, the mean EPG of GINs in all treatment (albendazole, tetramisole and ivermectin) group and control group (non-treated) were >1300 at day 0. But, mean EPG of GINs treatment group (albendazole, tetramisole and ivermectin group) were reduced to 0 at day 14. As compared with the control group, FECR% were 100% to all treatment group which implies, GINs were highly susceptible to most commonly used anthelimintic drugs. Thus, problem of GINs in goats of the study area seems to be very important as they were widely distributed in all areas participated in this study and albendazole, tetramisole and ivermectincan be used in the treatment of GINs infection in goats.

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REFERENCES

01. Baker, R.L., J.O. Audho, E.O. Aduda and W. Thorpe, 2001. Genetic resistance to gastro-intestinal nematode parasites in Gala and small East African goats in the sub-humid tropics. Anim. Sci., 73: 61-70.
02. Hoste, H., J.F. Terres-Acosta, V. Paolini, A. Aguilar-Caballero, E. Etter, Y. Lefrileux, C. Chartier and C. Broqua, 2005. Interaction between nutrition and gastrointestinal infection with parasitic nematodes in goats. Small Rumin. Res., 60: 141-151.
03. Fikru, R., S. Teshale, D. Reta and K. Yosef, 2006. Epidemiology of gastrointestinal parasites of ruminants in Western Oromia, Ethiopia. Int. J. Applied Res. Vet. Med., 4: 51-57.
04. Hutchinson, G., 2009. Nematode parasites of small ruminants, Camelids and cattle diagnosis with emphasis on anthelmintics efficacy and resistance testing formerly at Elizabeth Mcarthur agricultural Institute, New South Wales. Department Primary Ind., 2: 1-61.
05. Borji, H., M. Azizzadeh and M. Kamelli, 2012. A retrospective study of abattoir condemnation due to parasitic infections: Economic importance in Ahwaz, Southwestern Iran. J. Parasitol., 98: 954-957.
06. Bifaw, A., P. Wasihun and A. Hiko, 2018. Small ruminants gastrointestinal nematodiasis with species composition identification in Humbo District, Wolaita Zone, Ethiopia. Vet. Sci. Technol., Vol. 9,
07. Waller, P.J., 2006. Sustainable nematode parasite control strategies for ruminant livestock by grazing management and biological control. Anim. Feed Sci. Technol., 126: 277-289.
08. Domke, A.V.M., C. Chartier, B. Gjerde, J. Hoglund, N. Leine, S. Vatn and S. Stuen, 2012. Prevalence of anthelmintic resistance in gastrointestinal nematodes of sheep and goats in Norway. Parasitol. Res., 111: 185-193.
09. Seyoum, Z., Y. Demessie, B. Bogale, A. Melaku, 2017. Field evaluation of the efficacy of common anthelmintics used in the control of gastrointestinal nematodes of sheep in Dabat district, Northwest Ethiopia. Irish Vet. J., 70: 1-8.
10. Patten, T., B. Good, J.P. Hanrahan, G. Mulcahy and T. de Waal, 2011. Gastrointestinal nematode control practices on lowland sheep farms in Ireland with reference to selection for anthelmintic resistance. Irish Vet. J., Vol. 64. 10.1186/2046-0481-64-4
11. Terefe, G., U. Faji and Y.H. Tolossa, 2013. Field investigation of anthelmintic efficacy and risk factors for anthelmintic drug resistance in sheep at Bedelle District of Oromia Region, Ethiopia. Ethiopian Vet. J., 17: 37-49.
12. Kaplan, R.M., 2004. Drug resistance in nematodes of veterinary importance: A status report. Trends Parasitol., 20: 477-481.
13. De Graef, J., E. Claerebout and P. Geldhof, 2013. Anthelmintic resistance of gastrointestinal cattle nematodes. Flemish Vet. J., 82: 113-123.
14. CSA., 2008. Agricultural sample survey volume II. Central Statistic Authority, Addis Ababa, Ethiopia.
15. Bersissa, K. and N. Ajebu, 2008. Comparative efficacy of albendazole, tetramisole and ivermectin against gastrointestinal nematodes in naturally infected sheep in Hawassa, Southern Ethiopia. Rev. Med. Vet., 159: 593-598.
16. Yimer, A. and E. Birhan, 2016. Prevalence and identification of gastrointestinal nematodes of small ruminants in Northern Ethiopia. Middle-East J. Sci. Res., 24: 2602-2608.
17. Thrusfield, M., 2005. A Veterinary Epidomology. Blackwell Science, Hoboken, New Jersey,.
18. Coles, G.C., C. Bauer, F.H. Borgsteede, S. Geerts, T.R. Klei, M.A. Taylor and P.J. Waller, 1992. World Association for the Advancement of Veterinary Parasitology (W.A.A.V.P.) methods for the detection of anthelmintic resistance in nematodes of veterinary importance. Vet. Parasitol., 44: 35-44.
19. Balch, H., 2018. Prevalence and associated risk factor of gastrointestinal nematode parasites of small ruminant in Humbo district, Southern Ethiopia. DVM Thesis, Wolaits Sodo University, Ethiopia.
20. Muluneh, J., B. Bogale and M. Chanie, 2014. Major gastrointestinal nematodes of small ruminants in Dembia District, Northwest Ethiopia. Eur. J. Applied Sci., 6: 30-36.

21. Shankute, G., B. Bogale and A. Melaku, 2013. An abattoir survey on gastrointestinal nematodes in sheep and goats in hemex-export abattoir, Debre Ziet, Central Ethiopia. J. Adv. Vet. Res., 3: 60-63.
22. Emiru, B., Y. Amede, W. Tigre, T. Feyera and B. Deressa, 2013. Epidemiology of gastrointestinal parasites of small ruminants in Gechi District, Southwest Ethiopia. Adv. Biol. Res., 7: 169-174.
23. Elemo, K.K. and M.A. Geresu, 2017. Prevalence and risk factors of gastro intestinal parasitesof small ruminants in Sinana and Dinsho Districts of Bale Zone, South Eastern Ethiopia. Eur. J. Biol. Sci., 9: 1-8.
24. Kenea, T., J. Bekele and D. Sheferaw, 2015. Gastro-intestinal nematodes of sheep and goats in three districts of Kaffa and Bench Maji Zones, Southwest Ethiopia. Ethiopian Vet. J., 19: 67-76.
25. Admasu, P. and L. Nurlign, 2014. Prevalence of gastrointestinal parasites of small ruminants in Kuarit District, North West Ethiopia. Afr. J. Bas. Appl. Sci., 6: 125-130.
26. Rossanigo, C.E. and L. Gruner, 1995. Moisture and temperature requirements in faeces for the development of free-living stages of gastrointestinal nematodes of sheep, cattle and deer. J. Helminthol., 69: 357-362.
27. Gauly, M., M. Schackert, B. Hoffmann and G. Erhardt, 2006. Influence of sex on the resistance of sheep lambs to an experimental *Haemonchus contortus* infection. DTW. German Vet. Weekly, 113: 178-181.
28. Nalule, A.S., C.N. Karue and E. Katunguka-Rwakishaya, 2011. Anthelmintic activity of *Phytolacca dodecandra* and *Vernonia amygdalina* leaf extracts in naturally infected small East African goats. Livest. Res. Rural Dev., Vol. 23, No. 12.
29. Waruiru, R.M., 2002. Efficacy of closantel plus albendazole combination against naturally acquired and experimentally induced nematode infections in goats. Isr. J. Vet. Med., 57: 113-117.
30. Nsereko, G., P. Emudong, J.W. Magona, T. Odoch and J. Okwee-Acai, 2013. Anthelmintic efficacy of Albendazole, Levamisole and Ivermectin against Gastrointestinal Nematode (GIN) infections in goats on natural pastures in Gomba District, Uganda. Uganda J. Agric. Sci., 14: 75-85.
31. Kabasa, J.D., J. Opuda-Asibo and U. Ter Meulen, 2000. The effect of oral administration of polyethylene glycol on faecal helminth egg counts in pregnant goats grazed on browse containing condensed tannins. Trop. Anim. Health. Prod., 32: 73-86.
32. Regassa, F., L. Kebede, G. Mamo, B. Kumsa and T. Beyene, 2013. Efficacy of commonly used anthelmintic drugs in naturally infected sheep and goats in Central Oromia, Ethiopia. Res. J. Pharmac., 7: 48-53.
33. Terrill, T.H., R.M. Kaplan, M. Larsen, O.M. Samples, J.E. Miller and S. Gelaye, 2001. Anthelmintic resistance on goat farms in Georgia: Efficacy of anthelmintics against gastrointestinal nematodes in two selected goat herds. Vet. Parasitol., 97: 261-268.
34. Taylor, S.M., J. Kenny, H.W. Edgar, S. Ellison and L. Ferguson, 1997. Efficacy of moxidectin, ivermectin and albendazole oral drenches for suppression of periparturient rise in ewe worm egg output and reduction of anthelmintic treatment for lambs. Vet. Rec., 141: 357-360.